CLAIMS

1. A system for measuring low concentrations of stable and radioisotopes and/or low abundance isotopes, the system comprising:

a spectrometer assembly comprising a multi-slit assembly;

a coincidence laser spectrometer coupled to the spectrometer assembly comprising:

an optical detector coupled to the multi-slit assembly for specific detection of transmitted ions;

a voltage programmer flight tube coupled to the optical detector, the voltage programmer flight tube including a non-specific ion detector configured for the non-specific counting of transmitted ions, the flight tube further including an exit port at a first end thereof and a laser system at a second end thereof; and

a charged beam steering optics assembly positioned proximate the exit port of the flight tube.

2. The system of Claim 1, wherein the non-specific ion detector comprises an electron multiplier.

3. The system of Claim 1, further comprising a second non-specific ion detector mounted on the multi-slit assembly.

4. The system of Claim 1, wherein the optical detector is configured to detect transmitted ions by resonance scattering.

5. The system of Claim 1, wherein the optical detector is configured to detect transmitted ions by laser induced fluorescence.

6. An instrument comprising an Inductively Coupled Plasma Source Mass Spectrometer equipped with a multi-dimensional detector system wherein ions transmitted by the mass spectrometer are detected with high selectivity.

7. An instrument according to claim 6 wherein the multi-dimensional detector system comprises a plurality of sub-systems which provide a unitary response.

8. An instrument according to claim 7 wherein the multi-dimensional detector system comprises two sub-systems.

9. An instrument according to claim 7 wherein the sub-systems comprise a specific detector and a non-specific detector.

10. An instrument according to claim 8 wherein the two sub-systems of the multidimensional detector system are correlated temporally with high resolution.

11. An instrument according to claim 10 that provides co-incidence detection of transmitted ions.

12. An instrument according to claim 9 wherein the specific detector is based on optical spectrometry.

13. An instrument according to claim 12 wherein the specific detection of the transmitted ions is *via* resonance scattering processes.

14. An instrument according to claim 13 wherein the specific detection of the transmitted ions is *via* laser induced fluorescence.

15. An instrument according to claim 13 provided with means for collecting and detecting resonantly scattered photons efficiently.

16. An instrument according to claim 13 provided with means for the detection of the resonantly scattered photons with high temporal and spatial resolution.

17. An instrument according to claim 16 wherein the detection of resonantly scattered photons is *via* an imaging photomultiplier tube.

18. An instrument according to claim 9 wherein the second detector is a nonspecific ion counting device.

19. An instrument according to claim 18 wherein the nonspecific ion counting device is an electron multiplier.

20. An instrument according to claim 6 provided with means for manipulating the mean ion energy thereby reducing the relative spread of the ion beams energies.

21. An instrument according to claim 20 wherein the relative spread of ion beam energies may be manipulated to compress the optical bandwidth of the transmitted ions.

22. An instrument according to claim 20 provided with means for accelerating or decelerating the transmitted ion beam to manipulate the average ion beam energy and consequently the relative spread of ion beam energies.

23. An instrument according to claim 6 wherein a front-end collision/reaction cell is used to reduce the spread of the ion beam energies and compress the optical bandwidth of the transmitted ions.

24. An instrument according to claim 6 provided with means for manipulating the ion beam energies to bring the transmitted ion beam into resonance within the detection volume of the optical detector.

25. An instrument according to claim 24 provided with means for accelerating or decelerating the ion beam.

26. An instrument according to claim 12 wherein the ion beam is accelerated to induce an optical isotope shift by Doppler shifting.

27. An instrument according to claim 6 wherein a multiple exit slit assembly is incorporated.

28. An instrument according to claim 27 wherein the dual detector assembly is mounted upon the multiple slit assembly.

29. An instrument according to claim 28 wherein the dual detector assembly is mounted upon the axial exit slit.

30. An instrument according to claim 27 wherein additional nonspecific ion detectors are mounted upon the multiple exit slit assembly.

31. An instrument according to claim 30 wherein additional nonspecific ion detectors are mounted upon the off-axis exit slits.

32. An instrument according to claim 31 wherein the nonspecific ion detectors are electron multiplier devices.

33. A method for detecting and quantifying low concentrations of stable and/or radioisotopes and/or low abundance isotopes which comprises analyzing a sample in an instrument according to claim 6.

34. A method according to claim 33 wherein the species being detected is a radionuclide.

35. A method according to claim 33 wherein selectivity is enhanced by specific optical detection of transmitted ions.

36. A method according to claim 33 wherein selectivity is enhanced by specific isotopic selection via optical isotope shifts.

37. A method according to claim 33 wherein selectivity is enhanced by inducing an optical isotope shift by acceleration of the transmitted ions with subsequent Doppler shifting.

38. A method according to claim 33 wherein selectivity is enhanced by optical probing of hyperfine splitting.

39. A method according to claim 33 wherein nonspecific background is reduced by co-incidence detection of transmitted ions with subsequent improved detection limit.